

## **Appendix 7**

### **Biophysical Regions of Maine**

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## Biophysical Regions of Maine

The following description of Maine's 15 biophysical regions is excerpted from *The biophysical regions of Maine: Patterns in the landscape and vegetation* (McMahon 1990).

### Boundary Plateau Region

**Physiography:** The Boundary Plateau Region extends from the St. Francis River south to Penobscot Lake along the Maine-Quebec border and includes the lands west of the Saint John River and Boundary Mountains. The region is a relatively flat featureless plateau with few ponds and lakes. Elevations average between 1000' and 1200' except for a cluster of gently rolling hills in the southern section that rise to elevations of 1600' or more. The northwestern portion of the region is underlain by *mélange* – a sheared, fine-grained pelitic matrix mixed with angular and poorly sorted inclusions of diverse origins and geologic ages. Bedrock of the southern portion is dominated by weakly metamorphosed interbedded pelite (mudstone) and sandstone. The geology of this part of the state has not been mapped in detail.

**Climate:** Based on climate observations from the first half of the century (there are no weather stations in the region), the Boundary Plateau experiences the harshest winters in Maine. The frost-free season is approximately 80 days, which is less than half that of south coastal Maine. The April to November heat sum for the northern portion of the region (2100 degree days) is the lowest in the state. Average annual snowfall ranges from 100" to 110" and average minimum January temperature is less than 0° F. Average maximum temperature in July is 77° F, which is comparable to other regions in northern Maine. Average minimum July temperature (52° F) is the lowest in the state.

**Surficial Geology and Soils:** The Boundary Plateau Region is dominated by the most extensive stagnation moraine in the state. This moraine, which is composed of thin, course- textured ablation till, overlies dense basal till and is dissected by scattered outwash deposits, lake bottom deposits, and stream alluvium. Extensive areas of thin drift surround the moraine. This parent material, which is derived from fine-grained shales, slates, and phyllites, has given rise to very deep loamy soils. In the northern portion of the region, shallow (10"-20") somewhat excessively drained Thorndike soils occur on ridges of thin drift, with deeper (> 60") moderately well drained Chesuncook soils on midslopes, and somewhat poorly drained Telos soils on lower slopes.

Dense basal till typically underlies the course loamy Monarda and Burnham and the finer Daigle and Aurelie soils that are characteristic of valleys and broad flat uplands of the region. The basal till keeps the water table at or near the surface for 7 to 9 months of the year.

**Vegetation and Flora:** The poorly drained uplands and valleys of the region support large stands of *Picea rubens*, *Picea mariana*, and *Abies balsamea*. Drier ridges support northern hardwood species such as *Acer saccharum* and *Betula alleghaniensis*. Species richness of woody plants is low relative to the rest of Maine, averaging only 94 species. By comparison, midcoast Maine supports more than 190 species. The Boundary Plateau region also supports the highest concentration of ribbed fens in the state. A cluster of 14 ribbed fens is located in the slightly sloping lowland between the Daaquam River and the Southwest Branch of the St. John River – an area of impeded drainage.

## Saint John Uplands Region

**Physiography:** The Saint John Uplands extend from Fort Kent to the Seboomook Lake area and include the uplands east of the Saint John River as well as those to the east and west of the Allagash River. The eastern boundary of the region is roughly defined by the 1000' contour line. The terrain consists of rolling uplands dissected by broad valleys. Large lakes dominate the southern portion of the region. Elevations range from 800' in the valleys to 1000' to 2000' in upland areas. Several peaks rise above 2000' including Peaked Mountain (2270'), Round Mountain (2147'), Little Russell Mountain (2376'), Seboomook Mountain (2390'), and Green Mountain (2395').

The northern portion of the region is composed almost entirely of weakly metamorphosed pelites and sandstones except for a small pluton of syenite and monzodiorite in the Deboullie area. The bedrock geology is more complex to the south where intrusive rocks (primarily andesite and basalt) and mélangé occur. An unusual landform of the region are the cone-shaped mountains that dot the landscape where bedrock is of igneous origin.

**Climate:** The climate of the region is characterized by cold winter temperatures, low annual precipitation, and a short frost-free season. Average maximum July temperatures vary from 75° F in St. Francis to 77° F in Clayton Lake. Average annual precipitation (34") is the lowest in the state. A frost-free season of 80 to 100 days and a heat sum of 2300 degree days are comparable to that of the Boundary Plateau.

**Surficial Geology and Soils:** The rolling terrain of the region is covered by thin drift. Bedrock is at or near the surface except in the valleys where stagnation moraine tills, glaciofluvial deposits, and stream alluviums are present. In the northern portion of the region, however, dark gray, fine-grained shales and slates have given rise to deep, coarse, loamy soils. Soils in upland areas are generally shallow (10"-20") well-drained Thorndike and deep (20"-40") moderately drained Winnecook soils on ridge tops, with well to moderately well drained Elliottsville and Chesuncook soils on the midslopes. Very deep (> 60") somewhat poorly drained Telos and Daigle soils occur at lower elevations. In central and southern sections, where the terrain is flatter, deep, and somewhat poorly drained, Telos, Monarda, and Burnham soils are typical. Lyman, other similar skeletal soils, and soils of the Marlow catena are associated with the steep cone-shaped hills in this portion of the region.

**Vegetation and Flora:** Like the Boundary Plateau, the Saint John Uplands Region has a depauperate flora compared to other regions of the state. The eastern boundary of the region coincides with a topographically defined vegetation transition zone where species of boreal affinity are replaced by species characteristic of temperate regions. Woody species that are uncommon or nonexistent west of this transition zone include *Acer saccharinum*, *Amelanchier stolonifera*, *Arctostaphylos uva-ursi*, *Betula populifolia*, *Cornus rugosa*, *Dirca palustris*, *Fraxinus americana*, *Hamamelis virginiana*, *Ostrya virginiana*, *Prunus nigra*, *Quercus rubra*, *Quercus macrocarpa*, *Rhamnus alnifolia*, *Rhus typhina*, *Ribes hirtellum*, *Rosa palustris*, *Rosa virginiana*, *Salix petiolaris*, *Sambucus canadensis*, *Tilia americana*, and *Viburnum lentago*. The 1000' contour also roughly defines the northern and western limit of eccentric bog distribution in Maine.

## Aroostook Hills Region

Physiography: The Aroostook Hills Region extends from the Saint John River near Madawaska south to the Patten area. The western boundary is delineated by the 1000' contour line and the eastern boundary is defined by the calcareous bedrock and tills that underlie the Aroostook Lowlands. The region is characterized by gently rolling terrain with elevations averaging between 800' and 1000'. Scattered mountains occur in the Winterville area and on a small pluton north of Shin Pond. Topographic highs include Pennington Mountain (1578'), Green Mountain (1687'), and Mount Chase (2440'). Unlike the Saint John Uplands and Aroostook Lowlands, lakes and peatlands are abundant.

Bedrock of the region is almost entirely composed of weakly metamorphosed interbedded pelites, sandstones, and some limestone. Intrusives include a belt of metavolcanic rock that cuts across the central portion of the region and the quartz diorite pluton that underlies Mount Chase.

Climate: Except for maximum July temperature, which averages 78° F throughout the region, climate varies considerably from north to south. Winter temperatures, annual precipitation, and snowfall are lower in the north. On average, the length of the frost-free season is 20 days shorter in the central portion of the region than either the north or the south. The average minimum January temperature ranges from 4° F near Patten to -5° F near Squa Pan. Average annual precipitation ranges from 43" in Patten to 35" in Squa Pan and average snowfall ranges from 120" in Patten to 100" in the north. The climate is intermediate between the Saint John Uplands and the Aroostook Lowlands.

Surficial Geology and Soils: The eastern portion of the region has extensive but scattered deposits of glaciolacustrine sediments on which cedar swamps and peatlands have developed. The western portion is covered with thin drift and pockets of deeper till. Shallow (10"-20") excessively drained Thorndike silt loams occur on ridge tops, well to moderately well-drained Plaisted silt loams and Chesuncook loams occur on upper slopes, and finer poorly drained Aurelie and somewhat poorly drained Daigle soils are typical of valleys in the northern portion of the region. In the south, shallow course-grained Lyman or fine-grained Monson soils are characteristic of higher elevations, with somewhat poorly drained Colonel fine sandy loams and Telos loams below. Deep poorly drained Monarda loams are widespread in the valleys.

Vegetation and Flora: The western boundary of the region coincides with a vegetation transition zone where species characteristic of temperate regions are replaced by those of more boreal affinity. In addition to this transition zone, two peatland types, eccentric bogs and concentrically patterned raised bogs, reach their western limit in Maine here. This is apparently a topographic rather than a climatic limit – the total number and area of peat lands are generally less in mountainous well-drained terrain. Raised bogs are confined to the limited number of flat basins that are scattered among the hills and mountains, while eccentric bogs occur on the gentle slopes rising from these basins. Forest ecosystems are more diverse in the Aroostook Hills Region than in western portions of Aroostook County.

## Aroostook Lowlands Region

Physiography: The Aroostook Lowlands extend from the Saint John River west of Van Buren south to Linneus. The western boundary coincides with the westward extent of calcareous tills and bedrock. Elevations are relatively low (approximately 600' to 800') except for a few

scattered monadnocks (Squa Pan Mountain, Number Nine Mountain and Mars Hill), which rise above gently rolling terrain. Bedrock consists of weakly metamorphosed interbedded pelite, limestone, dolomite, and calcareous pelites and sandstones. These represent the most extensive calcareous formations in the state. Weakly metamorphosed andesite, basalt, and rhyolite occur in the central portion of the region. Igneous rocks are limited to two small granitic plutons west of Houlton.

Climate: The climate is relatively uniform throughout the region, with an average maximum July temperature of 77° F and a mean minimum January temperature of -1° F. While average precipitation (38") is higher than in other northern regions, average annual snowfall (100") is slightly lower. The frost-free season, which ranges from 95 to 110 days is longer than other regions in northern Maine.

Surficial Geology and Soils: The entire region is covered with till – much of it weakly calcareous. Two large stagnation moraines occur in northern and central portions. Deep till deposits contribute to the region's undulating topography. Bedrock is rarely exposed except for areas north and south of Mars Hill where numerous ledge outcrops occur. Soils are typically deep (> 60") fine loams derived from calcareous dark gray shale, siltstone, phyllite, and limestone. Well-drained Mapleton and Caribou soils are common on ridges and gentle slopes, while moderately well-drained soils occur on lower slopes. On the broad flat lowlands of the northwestern portion of the region, where the till is dense, soils in the Perham, Daigle, and Aurelie series occur. These areas are generally poorly drained. Scattered glaciofluvial deposits have given rise to well-drained sandy loams, particularly along the Aroostook River and some of its tributaries.

Vegetation and Flora: The Aroostook Lowlands support a number of calciphiles that are rare or do not occur elsewhere in Maine, including *Allium schoenoprasum*, *Anemone multifida*, *Astragalus alpinus*, *Carex sterilis*, *Cypripedium reginae*, *Drosera linearis*, *Equisetum variegatum*, *Erigeron hyssopifolius*, *Primula mistassinica*, *Polygala seneca*, *Rhynchospora capillacea*, *Salix candida*, *Salix exigua*, *Spiranthes lucida*, *Tofieldia glutinosa*, *Valeriana uliginosa*, and *Woodsia alpina*.

Two ecosystem types that are well developed in the southern portion of the region include circumneutral cedar swamps and weakly calcareous fens. Most of these are associated with the Carys Mills Limestone Formation. A number of woody species reach range limits in the region. Species reaching southern limits include *Crataegus laurentiana*, *Salix candida*, *Salix exigua*, and *Salix myricoides*. Species reaching northern limits include *Aralia racemosa*, *Aronia arbutifolia*, *Crataegus macrocarpa*, *Prunus serotina*, *Quercus macrocarpa*, *Rubus odoratus*, *Ulmus rubra* and *Vitis riparia*. Woody species richness averages 125, which is the highest of the four northern regions.

## Western Mountains Region

Physiography: The Western Mountains Region extends from Boundary Bald Mountain along the Maine-Quebec border to the Mahoosuc Range in southwestern Maine. The eastern boundary is defined by the 1000' contour line except for the northern portion, which includes several valleys of lower elevation west of Moosehead Lake. The region includes the Boundary Mountains to the north and the Longfellow Mountains to the south. These two mountain ranges are separated by a series of large lakes, including Umbagog, Upper and Lower Richardson,

Rangeley, and Flagstaff. The mountainous landscape is highly dissected by small, steep-sided streams. Elevations average between 1000' and 2000'.

The bedrock of the region is extremely complex. Dozens of plutons of various ages and compositions have intruded interbedded pelites and sandstones, which, as a result, are highly metamorphosed. A large complex of basement rock surrounds Kibby Mountain. Smaller occurrences of metavolcanic rocks are scattered throughout the region.

Climate: The Western Mountains are characterized by cool summer temperatures, low annual precipitation, and high snowfall. Average maximum July temperature (75° F) is lower than any part of the state except the Eastern Coastal Region. Average minimum January temperature (-1° F) is comparable to that of northern Maine. Average annual precipitation is low (39"), although some of the higher mountains produce a rain shadow effect with precipitation as high as 50" on windward slopes and less than 35" to leeward. Average annual snowfall is 110". A heat sum of 2300 degree days is lower than any region except the Boundary Plateau and the Saint John Uplands.

Surficial Geology and Soils: At elevations greater than 2500', soils are cold, acidic, and generally well drained. Shallow Saddleback soils occur on ridge tops, while deeper Enchanted soils occur on steep slopes. Both are cryic soils, which are characterized by a mean annual soil temperature between 32° and 47° F. Average summer soil temperature is less than 60° F if there is no water table present or less than 55° F if the water table is near the surface. Thin, freely drained, organic soils are also common at high elevations. These Ricker soils are derived from organic matter that has accumulated on a very thin mineral horizon. Saddleback and Enchanted soils are derived from mica schist and phyllite with some granite and gneiss. At middle and lower elevations, soils are typically deep, somewhat poorly drained Telos, Monarda, and Colonel coarse loamy soils. Ice-contact glaciofluvial deposits and stream alluvium fill many of the valleys. Soils derived from these deposits tend to be well to excessively drained gravels, sands, and sandy loams.

Vegetation and Flora: Stands of *Picea rubens* and *Abies balsamea* are common on ridge tops, and subalpine forest, which is made up almost exclusively of *Abies balsamea*, occurs at elevations greater than 2500'. *Acer saccharum*, *Betula alleghaniensis*, and *Fagus grandifolia* are common in the valleys. On treeless peaks, alpine communities such as dwarf shrub heath, sedge or rush meadow, fellfield, snowbank, and alpine bog occur. Ribbed fens are believed to reach their southern extent in North America in the northern part of this region.

Woody species of northern affinity that occur in the Western and Central Mountain Regions include *Betula cordifolia*, *Empetrum eamesii* ssp. *atropurpureum*, *Empetrum nigrum*, *Rubus chamaemorus*, *Salix uva-ursi*, *Vaccinium boreale* (historic), *Vaccinium uliginosum* ssp. *uliginosum*, *Vaccinium vitis-idaea*, and *Viburnum edule*. Woody species richness, which averages 105 species, is low relative to most other regions.

## Central Mountains Region

Physiography: The Central Mountains Region includes the Katahdin group and surrounding foothills. It also includes the highlands surrounding Moosehead Lake. The region contains the greatest relief in the state with elevations ranging from 600' to 5268'. Topographic highs include Baxter Peak (5268'), White Cap (3644'), Baker Mountain (3520'), Traveler (3541'), North Turner (3323'), South Turner (3122'), and Big Spencer (3230').

Bedrock is dominated by the Katahdin Pluton, which is composed of granite and granodiorite. A series of smaller plutons composed of gabbro and other ultramafic rocks underlies the Whitecap Mountain area. Bedrock of the surrounding hills is composed primarily of weakly metamorphosed pelites and sandstones. Melange and metavolcanic outcrops occur northeast of Moosehead Lake.

Climate: The climate of the Central Mountains resembles that of the Western Mountain Region except that summers are slightly milder, winters are slightly colder, and the frost-free season (approximately 100 days) averages 10 days longer. Mean maximum July temperature is 77° F and mean minimum January temperature is 1° F. As in the Western Mountains, annual precipitation is variable because of an orographic effect. Average annual precipitation is 38", while average annual snowfall is 120", the highest in the state.

Surficial Geology and Soils: The most extensive bedrock outcrops in the state occur in this region. The remaining landscape is covered with thin drift and till with scattered eskers and glaciofluvial deposits. Some of the deepest deposits occur in the ribbed moraine southeast of the Katahdin mountains, where coarse-textured Hermon soils predominate. As in the Western Mountains, the higher peaks are covered with cryic Saddleback and Enchanted soils, although these are not extensive. Where bedrock is near the surface, fine-textured, somewhat excessively drained Monson loams have developed. At lower elevations, in till derived from metasedimentary rocks, well-drained Elliottsville loams occur. Wetter and deeper Telos and Monarda soils are typical of valleys and flatter areas.

Vegetation and Flora: The Katahdin area is known for its alpine vegetation. Disjunct woody species that occur here and nowhere else in Maine include *Arctostaphylos alpina*, *Betula glandulosa*, *Betula minor*, *Cassiope hypnoides*, *Loiseleuria procumbens*, *Phyllodoce caerulea*, *Rhododendron lapponicum*, *Salix arctophila*, *Salix argyrocarpa*, and *Salix herbacea*. Woody species richness is high (132 species) on Mount Katahdin relative to the surrounding area.

As in the Western Mountains, the region is dominated by spruce-fir forests in poorly-drained valleys and on ridges, and northern hardwoods at middle elevations. Extensive stands of subalpine forest occur between the krummholtz zone and the 2500' contour.

## Western Foothills Region

Physiography: The Western Foothills parallel the Western and Central Highlands in a 10 to 20 mile wide band. Elevations in the region average between 600' and 1000'. The terrain is hilly. The entire region is underlain by metasedimentary rocks except for several small plutons of granite or granodiorite in the southwest. Next to the Aroostook Lowlands, some of the largest calcareous formations occur here. The southwest portion is characterized by moderately to strongly metamorphosed pelites, limestones, and dolostones.

Climate: The climate is intermediate between that of the Western Mountains and the Central Interior. Mean maximum July temperature is 79° F and mean minimum January temperature is 5° F. Average annual precipitation is 43", while average annual snowfall is 100". The frost-free season ranges from 110 to 140 days.

Surficial Geology and Soils: The northern portion of the region is dominated by the largest ribbed moraine in the state. The landscape consists of numerous hummocks and short parallel ridges. These are most conspicuous in the Millinocket and Pemadumcook Lakes area. Thin drift, occasional bedrock, and till composed of mica schist and phyllite with some granite and gneiss provide the parent material in southern sections. Valley soils north of the moraine are generally deep, somewhat poorly drained Telos and poorly drained Monarda loams, with shallower, better drained Monson and Elliottsville soils on upper slopes. Soils on the moraine tend to be deep, moderately well drained, coarse loamy Dixfield and stony excessively drained Hermon soils, while lower slopes are typically deep, poorly drained Brayton and Daigle soils. Soils in central and southern portions are generally better drained silts and fine sandy loams. Ice-contact glaciofluvial deposits and stream alluvium are scattered throughout the region.

Vegetation and Flora: The western boundary of the region roughly follows the 1000' contour, which marks a transition from temperate forest species to boreal species. In addition to the species that reach western limits between the Saint John Uplands and Aroostook Hills, a number of other woody plants are rare or do not occur west of the 1000' contour in this region. These include *Amelanchier canadensis*, *Carya ovata*, *Cephalanthus occidentalis*, *Comptonia peregrina*, *Cornus ammomum*, *Crataegus macrocarpa*, *Fraxinus pennsylvanica*, *Prunus serotina*, *Rubus hispidus*, *Rubus occidentalis*, *Rubus pennsylvanicus*, and *Viburnum acerifolium*. Woody species richness increases markedly from west to east.

### **Eastern Lowlands Region**

Physiography: The Eastern Lowlands Region includes the extensive lowlands west of the St. Croix River. Elevations range from 400' to 600' except for several hills (> 1000') in the West Grand Lake area. The landscape is one of low relief and contains the largest concentration of peatlands, marshes, and swamps in the state. Many of these occur in a concentric pattern that extends outward from the Chiputneticook Lakes. Northern and western portions are underlain by low-grade metamorphosed pelites and sandstones. Bedrock of eastern and southern portions is dominated by several large plutons composed of granite, granodiorite, and quartz syenite.

Climate: The climate is transitional between that of the coastal zone and the more continental climate of regions to the north and west. Precipitation decreases and snowfall increases from east to west. Mean maximum July temperature is 79° F and mean minimum January temperature is 3° F. Average annual precipitation is 46", which is slightly higher than the state average. Snowfall varies from an average of 70" in the east to 100" in the west.

#### Surficial Geology and Soils:

Glaciolacustrine deposits are extensive throughout the region, while glaciomarine clays are prominent in the St. Croix and Penobscot River basins. These deposits have given rise to mineral soils that are generally wet and dense. Depressions are frequently filled with organic soils. Somewhat excessively drained Monson and well-drained Elliottsville loams occur only at the highest elevations. Where bedrock is predominantly granite, Marlow, Dixfield, Colonel, and Brayton soils occur, while deep poorly drained Telos and Monarda loams are typical of lower slopes. A variety of peats, mucks, clays, and silts are common in depressions and on broad flat lowlands.

Vegetation and Flora: The Eastern Lowlands support the greatest variety of peatland ecosystem types in the state. All but coastal plateau peatlands occur here. Concentrically patterned raised bogs and eccentric bogs are particularly well developed in this region. The latter reaches its southern limit here. The southern boundary of ribbed fen distribution also passes through the region.

Woody species reaching northern limits in the region include *Cornus ammonum*, *Cephalanthus occidentalis*, *Crataegus brainerdii*, *Lonicera oblongifolia*, *Lonicera villosa*, *Myrica pennsylvanica*, *Rhus glabra*, *Rubus hispida*, *Rubus pensylvanicus*, *Rubus setosus*, *Viburnum recognitum*, and *Vitis novae-angliae*.

### Southwest Interior Region

Physiography: The Southwest Interior Region extends from the foothills of the Mahoosuc Mountains south to the headwaters of the Piscataqua River and includes Sebago Lake and the cluster of large lakes to the north and east. The varied landscape includes relatively flat sandy outwash plains along the Maine-New Hampshire border and south of Sebago Lake, gently rolling hills northeast of Sebago, and hilly terrain in the northern section. Elevations range from 200' to 600' in the south, and from 600' to 1000' in the north.

Bedrock of the region is dominated by the Sebago and Lyman plutons, both of which are composed of muscovite granite. Smaller intrusions of granodiorite, gabbro, diorite, and ultramafic rocks occur to the south along with metamorphosed pelites, sandstones, and small amounts of limestone and dolomite.

Climate: The climate is influenced by both maritime and continental weather patterns. Next to the South Coast, the Southwestern Interior has the warmest summer temperatures in the state. Mean maximum July temperature is 81° F. Winter temperatures are relatively mild, with a mean minimum January temperature of 6° F. Annual precipitation (47") is relatively high, and the region receives considerably more snowfall (82") than coastal regions. The May to October moisture surplus of approximately 3 cm is lower here than elsewhere in the state. This compares to approximately 6.3" in northern and coastal regions.

Surficial Geology and Soils: The Southwestern Interior contains the largest concentration of glaciofluvial and glaciomarine deposits in the state. Ice-contact deposits including flat-topped kame terraces and deltas and numerous kettles and eskers are common from the Fryeburg area to the Berwicks. Marine clays extend up the river valleys into the central portion of the region. Sandy glacial drift derived from granitic bedrock covers most of the region. This parent material has developed into very deep, somewhat excessively drained Hermon, Skerry, and Colton sandy loams. Adams and Croghan sands typically fill valleys that have not been inundated by marine clays and silts. Poorly drained Brayton and Naumburg sandy loams and Sebago peats typically fill depressions and kettles.

The warmest and driest soils in the state occur in this region, due to a relatively mild climate, low moisture surplus, and the abundance of coarse, excessively drained soils. Along with the South Coastal Region, this is the only part of the state that has a mesic soil temperature regime (an average annual soil temperature of > 45° F and < 60° F).

Vegetation and Flora: The northern boundary of the region occurs within a vegetation transition zone that parallels the mountains and foothills of southwestern and western Maine and then turns south to reach the coast in the vicinity of Penobscot Bay. This zone marks a transition from warm temperate to cool temperate and boreal vegetation. Species of northern affinity such as *Amelanchier sanguinea*, *Betula cordifolia*, *Lonicera villosa*, *Picea glauca*, *Pinus banksiana*, *Populus balsamifera*, *Ribes lacustre*, *Salix pyrifolia*, *Sambucus canadensis*, *Sorbus americana*, and *Viburnum trilobum* reach southern limits near Sebago Lake. Other boreal species, including *Abies balsamea*, and *Picea mariana*, do not form large stands.

Woody species reaching northern limits in the region include *Baptisia tinctoria*, *Hudsonia tomentosa*, *Ilex laevigata*, *Lindera benzoin*, *Quercus coccinea*, *Quercus ilicifolia* (except for one occurrence on Mount Desert Island), *Rhus copallina*, *Rubus arenicola*, *Sassafras albidum*, and *Vitis aestivalis*. Many of these species are associated with pitch pine-scrub oak barrens, an ecosystem type that reaches its northern limit in North Fryeburg.

### Central Interior Region

Physiography: The Central Interior Region extends from the foothills of the White Mountains near Buckfield in a northeasterly direction to the Penobscot River near Alton. From here the boundary swings south along the eastern shore of the Penobscot to Graham Lake. The region, which includes the lower drainages of the Kennebec and Penobscot Rivers, is characterized by flat to gently rolling terrain. Elevations average between 200' and 400', with the highest elevations occurring east of the Penobscot River in the Lucerne area. Bedrock geology of the region is complex. Igneous rocks include a large granitic pluton that underlies the Belgrade Lakes and smaller intrusions near Augusta and Athens. Bedrock is primarily composed of alternating bands of metasedimentary and metavolcanic rocks which strike northeast-southwest. Metamorphic grade generally increases from east to west across the region. Small pockets of metamorphosed calcareous rocks occur in the southwest.

Climate: Compared to other inland regions, the climate is moderate. Summers are warm and the frost-free season of 140 to 160 days is comparable to that of the coastal zone. Mean maximum July temperature is 80° F. Winter temperatures are relatively mild with a mean minimum January temperature of 10° F. Average annual precipitation (42") and snowfall (80") are intermediate between coastal and northern regions. The region's inland boundary roughly follows the 22" isopleth for potential evapotranspiration. Water surplus is typically less south of this line. This phenomenon is attributed to high summer temperatures and favorable wind movements, which increase evaporation and therefore the likelihood of summer drought.

Surficial Geology and Soils: Much of the region, particularly the Penobscot Valley, is covered with glaciomarine clays and silts. Extensive coarse-grained ice-contact deposits occur near Madison and Hinckley. Eskers and stream alluvium occur throughout the region, although these are more abundant to the southwest and northeast.

Soils in the region tend to be deep, well to moderately drained, coarse loams. Dixfield and Marlow fine-sandy loams are common on ridge slopes and somewhat poorly drained Colonel soils fill the valleys. Bangor silt loams and Thorndike soils predominate in the eastern portion of the region. In western sections, where glacial outwash is most abundant, Skerry and Becket sandy loams occur.

Vegetation and Flora: The flora of this region reflects its comparatively moderate climate. The region's northern and eastern boundaries occur in the center of the vegetational transition zone described in the Southwest Interior Region. Among forest ecosystems, there is a transition from a northern Appalachian forest of oak, pine, and mixed hardwoods in southern Maine to a spruce-fir-northern hardwood forest in northern and eastern Maine. Floristic changes further define this transition zone. Northern range limits of at least 60 woody and more than 250 herbaceous species are concentrated along the inland boundary of the region.

### **Eastern Interior Region**

Physiography: The Eastern Interior Region parallels the East Coastal Region in a 20 to 25 mile band that extends from Great Pond to the St. Croix River just north of Woodland. It includes the main stems and tributaries of the Narraguagus, Pleasant, and Machias Rivers. The topography is gently rolling with elevations averaging between 200' and 400'. Higher hills such as Peaked (938') and Lead (1475') Mountains are scattered throughout the region. Most of these peaks occur on the third largest pluton complex in the state (after Sebago and Katahdin). Smaller intrusions of gabbro and granodiorite are located along the region's seaward boundary. Wide belts of metasedimentary rocks derived from pelites, calcareous sandstones, and sulfidic quartz sandstone occur in the northern half of the region.

Climate: The climate shares characteristics of both the Eastern Lowlands and the East Coastal Region. Summer temperatures average 5° warmer than on the coast, with a mean maximum July temperature of 80° F. Winters are cooler and wetter, with a mean minimum January temperature of 5° F and average annual snowfall of 85" (roughly 1' more than the East Coastal Region). Average annual precipitation (47") reflects a strong maritime influence. The frost-free season averages 20 to 40 days shorter than that of the coastal zone.

Surficial Geology and Soils: Extensive ice-contact deltas and glaciofluvial deposits occur in the western half of the region. The surficial geology of the eastern half is dominated by large deposits of glaciomarine clays and silts. Till and thin drift are most extensive in the northern portion of the region. One of the state's largest examples of an ice-contact glaciomarine delta, Pineo Ridge, is located in the Towns of Columbia, Deblois, Cherryfield, and T18MD. Colton gravels and Adams sands are common on outwash plains, with poorly drained Vassalboro peats occurring in small pockets along the delta's margins. Colonel and Brayton fine sandy loams are typical of lower areas, with better drained Dixfield and Marlow fine sandy loams occurring on upper slopes and ridge tops.

Vegetation and Flora: Except on glacial outwash plains, spruce-fir is the dominant forest type throughout the region. Historically, *Pinus strobus* was abundant on sandy outwash soils. Most of these areas are now managed blueberry barrens. It is also the southern limit for concentric raised bogs.

### **South Coastal Region**

Physiography: The South Coastal Region parallels the Gulf of Maine in a 20 mile wide band that extends from Kittery to Cape Elizabeth. The physiography of this region is markedly different from points east. The Atlantic coastal plain, which is broad and clearly defined in states to the south, reaches its eastern extent near Portland. As a result, the South Coastal Region is

characterized by a relatively smooth coastline of large headlands, broad arcuate bays, and sand beaches. The terrain is relatively flat, with elevations rarely rising above 100'. Higher elevations occur on a pluton located near the headwaters of the York River and Goose Rocks Stream. Mount Agamenticus, which reaches an elevation of 691', is the highest point in the region. Bedrock is composed primarily of low-grade metasedimentary rocks which have been intruded by three large plutons composed of granite or syenite.

Climate: The climate of the South Coastal Region is the mildest in Maine. The number of heating days (3900) is greater, the frost-free period (160-170 days) is longer, and mean maximum July temperature 83° F is warmer than elsewhere in the state. Winters are also relatively mild with a mean minimum January temperature of 14° F and an average annual snowfall of 55", which is less than all other regions and less than half the state average. Although mean annual precipitation (45") is about average for the state, warm summer temperatures result in a relatively small moisture surplus (< 1.2"). This region also experiences less than half the fog of the East Coastal Region.

Surficial Geology and Soils: Along the immediate coast, soils are generally deep sands (where beaches occur) or shallow sandy loams that are well to excessively drained. Coarse loamy, very shallow Abram soils occur on hilltops, coarse, somewhat excessively drained, shallow Lyman soils occur on midslopes, and deeper (20"-40"), well-drained Tunbridge soils can be found on lower slopes. Inland, deeper sandy soils derived from glaciofluvial material are typical. The most extensive coarse-grained glaciomarine deposits in the state occur in the central portion of the South Coastal Region and along its western margin. Deep, excessively drained sandy-gravelly Colton soils and sandy Adams soils are common in this area, especially in the vicinity of Kennebunk Plains, a glaciomarine delta. Poorly drained Naumburg soils and scattered organic deposits have developed in the region's many kettles and depressions.

The southwestern portion of this region and the Southwest Interior contain the only soils with a mesic temperature regime (an average annual soil temperature of > 45° F and < 60° F) in the state.

Vegetation and Flora: The vegetation of the South Coastal Region resembles that of the Atlantic Coastal Plain. Ecosystems that reach their northern extensions here include sandplain grasslands and oak-hickory forests. This is the only part of the state where *Quercus alba* and *Carya ovata* occur in large stands. The largest coastal pitch pine communities in Maine occur on excessively well-drained, nutrient-poor sandy soils in Scarborough, Kennebunk, and Wells. Small stands of pitch pine-scrub oak and the state's most extensive salt marshes are also located in this region.

Subarctic maritime species that reach southern limits in the South Coastal Region include *Empetrum nigrum*, *Hudsonia ericoides*, and *Mertensia maritima*. In addition, the distribution of several coastal species associated with sand beaches extends along the mid and southern coasts, including *Artemisia caudata*, *Euphorbia polygonifolia*, and *Hudsonia tomentosa*. An ecosystem that is believed to reach its southern limit here is the raised bog.

## Midcoast Region

Physiography: The Midcoast Region extends from Cape Elizabeth to Pemaquid Point and inland approximately 20 miles from the Gulf of Maine. It is a landscape of flat to gently rolling

terrain with elevations ranging from sea level to 200' and averaging 100'. From Sheepscot Bay to Bailey Island, where bedrock is frequently exposed or covered by thin drift, low but more rugged topography is typical.

This portion of the coast, which is characterized by long narrow peninsulas and islands, is a classic example of a drowned coastline. The northeast-southwest trending valleys and ridges reflect the strike of the underlying bedrock. Most of the region is underlain by highly metamorphosed sandstones and pelites. Long ridges are typically the crests of sharply folded layers of bedrock, while softer sediments that accumulated in concave portions (synclines) have been eroded into long valleys. Granitic plutons are small and widely scattered. Outcrops of metavolcanic rocks occur north and inland of Casco Bay.

Climate: The temperature regime of the Midcoast Region resembles that of the Penobscot Bay Region. Mean maximum July temperature is 79° F, with a slight decrease in temperature from west to east. The mean minimum January temperature of 13° F is slightly warmer than that of the two regions to the east, while annual precipitation (45") is noticeably less. Average annual snowfall (74") is higher here than in other coastal regions. The average number of heating degree days (3500) is substantially higher than in the East Coastal Region.

Surficial Geology and Soils: Headlands and ridges are typically covered with shallow (10-20") somewhat excessively drained Lyman fine-sandy loams and very shallow Abram sandy loams. Well-drained, coarse loamy Tunbridge soils generally occur on midslopes where till is derived from schists and gneiss. Finer grained, moderately well-drained Buxton soils occur over glaciomarine deposits at middle elevations. Deep, often highly dissected glaciomarine clays and silts are common in low-lying areas.

Vegetation and Flora: The vegetation of the Midcoast Region reflects the moderating influence of the Gulf of Maine. Summer temperatures are cooler and seasonal rainfall higher than inland regions and fog is a frequent occurrence. The southernmost extent of the coastal spruce-fir forest, which occurs in Harpswell, can be attributed to this. This ecosystem type is limited to a few small but representative stands. Another vegetation type that is well developed along this portion of the coast is the coastal pitch pine community. *Pinus rigida*, and a common associate *Corema conradii*, grow on sand dunes and bedrock outcrops in the coastal zone. Both moderate winter temperatures and thin and excessively well-drained soils are thought to contribute to this ecosystem's presence here.

Woody species that reach their northern limits along this portion of the coast include *Hudsonia tomentosa*, *Lonicera dioica*, *Nyssa sylvatica*, *Quercus coccinea*, *Rhus copallina*, *Sassafras albidum*, *Smilax rotundifolia*, and *Toxicodendron vernix*. Woody species richness averages 191 species, the highest in the state.

## Penobscot Bay Region

Physiography: The Penobscot Bay Region, which is bounded by Pemaquid Point to the west and Brooklin to the east, includes the shorelines and islands of Penobscot and Muscongus Bays and extends approximately 20 miles inland from the Gulf of Maine. The terrain is knobby, with frequent bedrock outcrops and several small mountains. Average elevation is 200'. Topographic highs, which occur at the tops of the granitic plutons, which form the Camden Hills and the Blue Hill Peninsula, include Mt. Megunticook (1385') and Blue Hill (934'). The bedrock of Penobscot

Bay's east shore and the Muscongus Bay area is predominantly granite. The west shore of Penobscot Bay and Pemaquid Point are composed of metamorphosed pelites and sandstones. Metavolcanic rocks are restricted to the Cape Rosier area.

Climate: In most respects, the climate is intermediate between that of the East Coastal and Midcoast Regions. Although there is a distinct maritime influence, with high annual precipitation and frequent fog, higher summer temperatures result in a lower moisture surplus than in the East Coastal Region. Mean maximum temperature in July is 77° F, which is approximately 4° warmer than the East Coastal Region and slightly cooler than the midcoast. Mean minimum temperature in January is 11° F, approximately 2° cooler than the East Coastal Region. Although average annual precipitation (49") is higher than in any other region, average annual snowfall (63") is less than that of the East and Midcoast Regions. This region also has a shorter growing season (140 days) than abutting coastal regions.

Surficial Geology and Soils: East of Penobscot Bay, higher elevations are generally covered with thin drift, which provides the parent material for shallow, coarse loamy Lyman soils. West of Penobscot Bay, upland areas are dominated by deep (> 60"), coarse loamy Tunbridge and deep, coarse loamy Dixfield soils. Lyman soils, which tend to be somewhat excessively drained, generally occur on ridge tops, while well and moderately well drained Tunbridge and Dixfield soils occur on ridge slopes. Coarse-grained, but poorly drained Colonel and Brayton soils are characteristic of lower ridges and toe slopes. Valleys and lowlands throughout the region are filled with deep, poorly drained glaciomarine clays and silts.

Vegetation and Flora: The Penobscot Bay Region supports vegetation that is transitional between the coastal spruce-fir ecosystems of the east and a forest dominated by *Pinus strobus* and *Quercus rubra* to the southwest. Species of northern affinity, such as the distinctive subarctic maritime flora of the East Coastal Region are present only on offshore islands here. The coastal spruce-fir forest is no longer continuous; it occurs in small stands on islands and exposed headlands. Twenty woody species that reach their northern limits in Maine or New Brunswick reach a coastal limit in the eastern portion of the Penobscot Bay Region. These include *Acer saccharinum*, *Alnus serrulata*, *Aralia racemosa*, *Carpinus caroliniana*, *Carya ovata*, *Castanea dentata*, *Ceanothus americanus*, *Chamaecyparis thyoides*, *Fraxinus pennsylvanica*, *Juniperus virginiana*, *Platanus occidentalis*, *Quercus macrocarpa*, *Quercus alba*, *Salix coactilis*, *Salix nigra*, *Salix planifolia*, *Viburnum lentago*, *Vitis labrusca*, *Vitis novae-angliae*, and *Vitis riparia*. Most of these species are characteristic of warm temperate regions. This represents the highest concentration of northern range limits along the coast. Along with the southwestern portion of the East Coastal Region, this portion of the Penobscot Bay Region marks the eastern end of the transition zone.

## East Coastal Region

Physiography: The East Coastal Region parallels the Gulf of Maine in a 20 mile wide band that extends from Mount Desert Island and Isle au Haut east to Passamaquoddy Bay (in the vicinity of Perry). The region is characterized by low ridges surrounded by poorly drained, relatively flat terrain. Elevations are generally less than 100' with the exceptions of the mountains of Mount Desert Island and the Tunk Lake area, which rise to elevations of 1000' or more. Topographic highs occur on plutons of coarse-grained granitic rocks, while the more easily eroded finer-grained intrusive and metamorphic rocks from Roque Bluffs to East Quoddy Head have been worn to lower elevations. Bedrock is predominantly igneous, except for outcrops of metavolcanic rocks near Columbia Falls and in the Cobscook Bay area. Most of the headlands

and islands between Isle au Haut and Jonesport are composed of biotite or muscovite granite. Gabbro, diorite, volcanic rhyolite, and basalt become abundant to the east.

Climate: The climate of the East Coast Region is strongly moderated by the Gulf of Maine. The combination of land breezes in the summer and northeasters in the winter creates a climate characterized by cool summers, high annual precipitation, frequent summer fog, and a relatively high moisture surplus. Mean minimum January temperatures are the warmest in the state, ranging from 15° F in Eastport to 14° F in Bar Harbor. The mean maximum July temperature in Eastport (63° F) is lower than any weather station record in the state except St. Francis, which is located 180 miles to the north, and the Oquossoc and Cupsuptic stations, which are located at elevations of more than 1600'. Average annual precipitation ranges from 44" to 50". Unlike other regions of the state, more precipitation occurs in the winter than in the summer. While the entire Maine coast experiences fog during the summer months, the East Coastal Region is shrouded by fog for twice as many hours as western Penobscot Bay and south.

Surficial Geology and Soils: On ridge tops, at high elevations, and on outer peninsulas, soils are generally poorly developed, acidic (due to the poor buffering capacity of the parent material), coarse-textured, and shallow. These areas are dominated by coarse-loamy Lyman soils and sandy-skeletal Schoodic soils, both of which tend to be excessively drained and less than 20" in depth. Most low-lying areas of the region, which were inundated by seawater as the glaciers receded, are covered with deep marine clays and glaciolacustrine deposits. On the slopes of ridges formed by deposits of glacial till, deep, moderately well drained, loamy soils of the Dixfield series are typical. The eastern edge of the Pineo Ridge delta, which is comprised of coarse-grained glaciomarine sediments, crosses the region's western boundary.

Vegetation and Flora: Two ecosystem types that are particularly well developed in the East Coastal Region are coastal spruce-fir forests and coastal raised peatlands. East of Penobscot Bay, most forests contain a substantial percentage of spruce and fir. This coastal spruce-fir ecosystem has been attributed to the cool growing season, ample moisture supply, and fog-laden winds that characterize the region's climate. *Picea rubens* and *Abies balsame* are community dominants. *Betula papyrifera*, *Acer rubrum*, and *Picea glauca* are also common. A second ecosystem type that is confined to the coastal zone along the Bay of Fundy is the coastal plateau peatland. These peatlands, which generally occur within 5 miles of open ocean, reach their southern limit in North America on Mount Desert Island. Their development is related to a low ratio of evapotranspiration to precipitation. Cool temperatures and frequent fog reduce evaporation resulting in a relatively high annual moisture surplus, creating favorable conditions for *Sphagnum* growth.

In addition to these ecosystems, a number of plant species reach range limits in the vicinity of Mount Desert Island. Subarctic maritime species that reach southern limits in coastal headland communities or in coastal raised peatlands include *Aster foliaceus*, *Iris hookeri*, *Lomatogonium rotatum*, *Montia lamprosperma*, *Primula mistassinica*, *Rubus chamaemorus*, and *Sedum rosea*. In addition, *Empetrum nigrum*, a subarctic species that occurs on headlands as far south as the Cumberland County coast, is abundant in this region.

The southwestern end of the East Coastal Region marks the eastern extent of the transition zone. Thirteen wood species reaching limits in Frenchman Bay, Mount Desert Island, or Schoodic Point include *Clethra alnifolia*, *Cornus florida*, *Cornus foemina* ssp. *racemosa*, *Decodon verticillatus*, *Juglans cinerea*, *Kalmia latifolia*, *Pinus rigida*, *Prunus maritima*, *Quercus bicolor*, *Quercus ilicifolia*, *Quercus velutina*, *Rhododendron viscosum*, and *Rubus odoratus*.